

Tricon Digital Diagnostics Enable Risk-informed Surveillance Test Interval Extensions/Eliminations

The NRC is initializing endorsement of industry guidelines which credit Tricon’s digital, continuous self-monitoring diagnostics as the basis for lengthened surveillance test intervals and possible elimination.

Challenge

Approximately 66% of the total operating costs of today’s plants are operations and maintenance (O&M) and, more specifically, preventative maintenance which includes inspections, calibrations and testing activities based on periodic frequency rather than the condition of the system. Extending these maintenance intervals and reducing manual testing activity would reduce overall O&M costs, driving down a nuclear power plant’s bottom line.

Solution

Digital online monitoring and self-diagnosis are inherent features of Tricon. Implementing these capabilities will enable utilities to leverage today’s — and tomorrow’s — digital technology to enhance and ultimately lower the cost of plant operations. Simplified analysis, streamlined troubleshooting, corrective maintenance procedures, enhanced maintenance efforts and efficiencies, and minimized operator duties are just some of the benefits.

NRC-Approved Since 2001

In 2001, the NRC issued a Safety Evaluation Report (SER) approving Tricon Version 9 for use in 1E I&C systems, making Tricon the first Triple Modular Redundant (TMR) system to be qualified by the NRC. Framatome’s third SER — the second for the continuously current Tricon platform (V10) — notes the following NRC approval of the system’s extensive diagnostics:

“Section 3.4.3 of this SE discusses diagnostics and self-test capabilities. The NRC staff reviewed these self-test capabilities, and finds them suitable for a digital system used in SR applications in nuclear power plants. It may also be possible to use some of these diagnostic capabilities to modify or eliminate certain TS-required periodic surveillance tests; however this is a plant specific, application-dependent issue and, therefore, is not addressed in this SE. The licensee must provide any such surveillance test modifications or eliminations as part of plant-specific licensing amendment requests. This determination will be reviewed by the NRC staff when the applicant requests NRC approval for the installation of a SR system based on the Tricon V10 platform.”

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is **our** everyday **commitment**



Customer benefits

- Risk-based surveillance test intervals lead to **reduced maintenance**
- Condition assessment via online monitoring **reduces costly time-interval based preventative maintenance procedures**
- **Extended calibration intervals** of sensor instrument loops based on performance of instrument channels as evaluated by online monitoring systems **detecting drift or deviation**
- Self-diagnostics **reduces the risk of human error** during routine surveillance and maintenance
- **Reduced manpower requirements** – automated system surveillance testing eliminates significant manual effort

Highlights of Tricon's Extensive, Continuous Self-Monitoring

- All diagnostic fault information is accessible by the control program and the operator to modify control actions or even by **direct automated maintenance procedures**.
- Each type of digital output module executes a particular output voter diagnostic (OVD) for every point. Loopback on the module allows each microprocessor to read the output value for the point to **determine whether a latent fault exists** within the output circuit.
- The power modules have built-in diagnostic circuitry which checks for out-of-range voltages and over-temperature conditions. **A short on a channel disables the power regulator rather than affecting the power bus.**
- Tricon system cycles control between the two healthy I/O modules approximately every hour so that each **undergoes complete diagnostics** on a regular basis.
- All modules sustain complete, ongoing diagnostics for each channel. Failure of any diagnostic on any channel activates the module fault indicator, which in turn activates the chassis alarm signal. The module is **guaranteed to operate properly in the presence of a single fault.**
- The **enhanced diagnostic monitor** is an application which monitors the hardware health of Triconex controllers and allows **users to effectively troubleshoot the safety system** during maintenance.

Extract from the Lightwater Reactor Sustainability Program document INL-EXT-19-54251, "Technical Specification Surveillance Interval Extension of Digital Equipment in Nuclear Power Plants: Review, Research and Recommendations"

*"The Tricon V10 PLC system provides **continuous self-testing**, including monitoring memory and memory reference integrity, using watchdog timers, monitoring communication channels, monitoring central processing unit status, and checking data integrity. The Tricon V10 PLC system performs self-tests and I/O validation on each module. The Tricon V10 PLC system TMR architecture provides **continuous self-testing** to detect, tolerate, and alarm on single internal failures. The internal self-test functions are **transparent to the application program and are an integral part of the base platform operating software**. These diagnostics check each main processor, as well as each I/O module and communication channel, **transient faults are recorded and masked** by the hardware majority-voting circuit. Persistent faults are diagnosed, and the faulted module can be replaced or operated in a fault-tolerant manner until replacement is complete.*

*System diagnostics monitor the health of each main processor module as well as each I/O module and communication channel. The main processor modules process diagnostic data recorded locally and data received from the input modules level diagnostics in order to make decisions about the health of the input modules in the system. **All discrepancies are flagged and used by the built-in fault analyzer routine to diagnose faults**".*

Compliance to IEE 603-1991 Clause 5.7

A Tricon-based safety-related digital modernization provides enhanced self-testing and diagnostic functions that reduce the likelihood of undetected failures. The requirement for periodic testing is addressed by channel calibrations which are performed online using a bypass capability or offline during outages. Calibration and testing can be performed according to approved procedures that can be credited with significant reduction in surveillance techniques and surveillance intervals due to the SER approval criteria of Tricon.

Compliance to Regulatory Guides

In the approved Tricon Topical Report, NRC staff determined that Tricon V10 meets the criteria of RG 1.22, "Periodic Testing of Protection System Actuation Functions"; RG 1.118, "Periodic Testing of Electric Power and Protection Systems" Rev 3; and IEEE STD-338-1987, "Standard Criteria for Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems".

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